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ABSTRACT

This paper presents a detailed description of two information-processing tools, scripted cooperation and the use of knowledge mapping, and their potential application to deaf education. Scripted cooperation is a method for structuring the cooperative learning activities of student pairs. The roles and activities of the participants are scripted. The cognitive, affective, metacognitive, and social activities of an interacting dyad can be directed by the use of an appropriate script. Knowledge mapping involves the presentation of information via two-dimension node-link representations. Central ideas are contained in nodes and are hooked to other ideas using a series of named "links" or relationships. The labeled links allow for the specific articulation of ideas and their connections and also provide students with retrieval cues. The efficacy of scripted cooperation and knowledge maps are assessed within the context of an undergraduate biology course. The role of knowledge maps in learning high school social studies material is also examined. (Author/DB)

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SCRIPTED COOPERATION AND KNOWLEDGE MAPS: INFORMATION PROCESSING TOOLS APPLIED TO DEAF EDUCATION

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Abstract

This paper presents a detailed description of two information-processing tools, scripted cooperation and the use of knowledge mapping, and their potential application to deaf education.

Scripted cooperation is a method for structuring the cooperative learning activities of student pairs. While cooperative learning of some kind has been utilized in almost every classroom, scripted cooperation differs in a number of important ways from more usual methods of grouping students for classwork. It differs from peer-tutoring approaches in that both participants are equal partners in the learning experience. The crucial part of this method is the "script," which might be thought of as being analogous to a theatre script. The roles and activities of the participants are scripted. The cognitive, affective, metacognitive, and social activities of an interacting dyad can be directed by the use of an appropriate script.

The basic script involves two students reading a section of text (or other task). One partner then recalls the material which has been read and the other partner tries to provide feedback on errors made. Both partners elaborate on the material to make it memorable and proceed to the next section. They then exchange roles for the next section of the text. While other cooperative learning systems have been shown to enhance academic achievement, the use of scripted cooperation involves the controlled activation of information-processing strategies, making those strategies public by the overt nature of the recall, providing models of how to process the information by allowing one student to observe, and exposing students to the complex nature of learning by the alternation of roles in which they experience varying emphases on cognitive and metacognitive activity.

The second information-processing tool of interest is the use of knowledge mapping. This particular technique was developed from prevailing theories of memory and involves the presentation of information via two-dimensional node-link representations of information. Central ideas are contained in nodes and are hooked to other ideas using a series of named "links" or relationships (see Figure 1). While there are many variations on this method (e.g., semantic webbing), few methods provide a means to label the relationships between ideas. The provision of labelled links allows for the specific articulation of ideas and their connections. The use of such labelled links also provides the students with a set of powerful retrieval cues.

There are a number of potential advantages in using such a method with deaf students. The use of such maps has been shown to help teachers organize lessons, lectures, etc. It allows the learner to use both spatial and verbal cues and encoding schemes to understand and retain

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a knowledge domain. It could be viewed as a two-dimensional language in contrast to the more linear nature of text.

The efficacy of scripted cooperation and knowledge maps as learning tools are assessed within the context of an undergraduate biology course. The role of knowledge maps as advance organizers or review tools as aides to learning high school social studies material are also examined. Information gathered during the development of appropriate knowledge maps to accompany a social studies course at a high school primarily consists of teachers' and students' reactions to the maps.

The data gleaned from these preliminary assessments of the use of scripted cooperative learning and knowledge mapping in two different situations will be included in the symposium presentation of the material.

Introduction

Research on the education of the deaf has been largely "issue" oriented. Examples of dominating issues include the continued debate between advocates of oralism and sign language systems over the desirability and efficacy of these approaches and problems associated with mainstreaming. Research on developing curricula and teaching methodologies has largely focused on the areas of reading, language, and speech teaching (Moores, 1982). Traditional subject matter areas (e.g., science) have received little attention.

In addition to the dearth of research on developing and evaluating curricula and teaching methods in subject matter areas such as science and social studies, there has also been relatively little research on the teaching of cognitive skills to the hearing impaired (Martin, 1985). There has been a growing recognition of the need for study-strategy training for college students in general (McKeachie, 1988). The need for such training for hearing-impaired students may be even more critical. Martin (1985) noted that instructors of hearing-impaired students at Gallaudet University frequently expressed concern and frustration at their students' deficiencies in problem-solving skills and skills in manipulating higher-order concepts and abstractions.

The present paper describes two information-processing tools (the use of knowledge maps and scripted cooperation) which have potential to address the need to develop methodologies in curricular areas outside the traditional areas of investigation (e.g., reading) and the need for instruction in cognitive strategies. These tools have been used successfully with hearing students and appear to have promise for use with hearing-impaired students.

Knowledge Maps

One alternative to typical methods of presenting information is the use of knowledge maps. Knowledge maps are two-dimensional representations of information. Idea units are contained in nodes and are connected to other ideas using a series of named "links" or relationships (see Figures 1 and 2 for examples of a knowledge map and "link" types). This particular kind of information representation is based on prevailing models of memory (e.g., Anderson, 1983).

The use of knowledge maps in presenting information to deaf students may help bypass some of the difficulties commonly experienced by many deaf students in processing text. Moores (1982) noted that deaf students have difficulty with subject matter that relies on knowledge of English. He further noted that in curricular areas involving traditional academic subjects (e.g., history) the tendency has been for teachers to rely on texts, etc., designed for students with normal hearing, potentially exacerbating the difficulties experienced by deaf students in these subject areas. In one survey of academic achievement (Gentile, 1972), science achievement among hearing-impaired students was well below norms for hearing students. The average eighteen-year-old deaf student has approximately fourth grade reading skills (Trybus & Karchmer, 1977). Reading levels of the select group of deaf students who attend post-secondary schools is higher but still below that of hearing peers. Deaf students have been

shown to differ significantly from hearing peers in syntactic knowledge (Charrow, 1974), lexical knowledge (Walter, 1978), and ability to detect main ideas in text (Coggiola, 1982; cited by Long, & Aldersley, 1984). The effects of complex syntax and difficult vocabulary have been shown to have deleterious effects on reading comprehension (Drury, 1981). In areas of study such as biology, these factors can have an enormous impact.

Presentation of Information in Knowledge Maps

The use of "mapping" as a learning strategy has been shown to be effective. However, training students to specifically use "mapping" as a learning strategy requires a great deal of time (McKeachie, 1984). Many teachers may be unwilling to devote this kind of time to the specific teaching of a strategy in the context of ongoing instruction in a particular subject matter.

Alternatively, knowledge maps can be used as the primary vehicle for the presentation of information. This approach has a number of potential advantages. Map development assists the teacher in understanding the nuances of the knowledge domain and helps the teacher to identify portions of the domain that may pose learning difficulties (Camperell & Smith, 1982; Hawk & McLeod, 1983). Knowledge map presentations also have the potential to communicate equivalent information but with a reduction in syntactic complexity as compared to text presentations of the same information. In addition, the use of knowledge maps makes the structure of the information apparent, signaling the main ideas and informing the students about the interrelationships of ideas and the logical connections between higher-order and lower-order concepts (Armbruster & Anderson, 1984; Alverman, 1986; Darch, Carnine, & Kameenui, 1986). A further potential advantage of the use of knowledge maps is that it allows the learner to use both spatial and verbal cues in the acquisition and retrieval of information.

Research with hearing students has shown that students who learn material from knowledge map presentations of the information subsequently recall main ideas better than students who study text versions of the same information (O'Donnell et al., 1988; Rewey, 1988). They also seem to learn some transferable skills; students who have studied one set of materials in the form of knowledge maps outperform students who have not been exposed to the maps on a subsequent task (O'Donnell, Dansereau, & Pitre, 1988). The benefits of knowledge map presentations are most clearly seen when the target text is procedural in nature (O'Donnell et al., 1988)--a kind of text which has been shown to be difficult to process (Hythecker et al., 1986). In addition, students have responded more favorably to the presentation of information in the form of knowledge maps than corresponding text versions of the same materials (O'Donnell et al., 1988).

Knowledge Maps and the Hearing Impaired

Students at the National Technical Institute for the Deaf (NTID) have participated in a training program in which they learned to use a "mapping" system as a learning strategy (Long & Aldersley, 1984). The "mapping" system used was similar to creating knowledge maps. The goal of the training program was to improve students' skills in identifying main ideas in text and ability to summarize the gist of text passages. The results of an evaluation of this training program indicated that students who were taught to use this method of information representation showed significant improvement in their ability to summarize passages which they had "mapped" and also improved in their ability to summarize passages which they had not mapped. Positive outcomes have also been found with hearing students who were taught "knowledge mapping" as a learning strategy (Holley & Dansereau, 1984).

Although most of the work on the use of knowledge maps to date has been conducted with hearing students, the results from the work of Long and Aldersley indicate that this tool can be beneficial for hearing-impaired students also. In addition, both deaf and hearing students in a variety of graduate classes at Gallaudet University have responded favorably to the use of knowledge maps in the presentation of information.

Summary. The use of knowledge maps in the presentation of information in subject matter areas such as science, appears to have some potential to improve achievement by deaf students in these areas. It may do so by reducing the syntactic complexity of the materials, improving the organization of the information, highlighting the main ideas and how they connect to lower-order ideas in the material, and make easily apparent the ordering of events in particular material.

Cognitive Strategy Training

There has been an increasing recognition of the need to teach cognitive strategies to students at all levels (Martin, 1985; McKeachie, 1988). Martin (1987) noted that results of the National Assessment of Educational Progress indicated that students in general on a national level are faltering in problem-solving skills. As mentioned previously, he also reported the deep concern and frustration expressed by instructors of deaf students about perceived student deficiencies in problem-solving. In response to this need, Martin (1985) instituted a study of the efficacy of a program specifically designed to teach thinking skills. This program, entitled "Instrumental Enrichment," was developed by Feuerstein (1978). The use of this program with hearing-impaired students has been shown to be successful, resulting in improved achievement in specific academic and work-habit areas. Difficulties experienced in the implementation of the

program relate to the intensive training needed for instructors who often lack the necessary pedagogical skills to implement the program.

Despite the success of programs such as Instrumental Enrichment, many teachers can be expected to be reluctant to undergo the intensive training necessary in order to implement the program effectively, and many teachers may feel reluctant to devote class time to the specific teaching of content-free cognitive strategies which are then applied to the content. Teaching content and teaching cognitive strategies have traditionally been treated as two separate activities by some teachers.

One potential reason why such separations occur is the absence of an overall conceptual framework within which to couch the goals and outcomes of educational programs. Without such an overall framework, instruction and assessment is fragmentary and teaching of content is seen as different from the teaching of cognitive strategies. Dansereau (1986) developed a model of cognitive task performance which appears to have the potential to provide an overall framework for the conceptualization of the learner in the process of instruction which allows for the teaching of content and strategies to be encapsulated within the same framework. This framework is terms CAMS.

In the CAMS model, the success of the learner depends on the appropriate interaction of cognitive (C), affective (C), metacognitive (M), and social (S) activities. Within this framework, cognitive activities include comprehension and recall. Affective activities include motivation, anxiety, and concentration. Metacognitive activities include comprehension monitoring, error detection, and correction. Social activities include an awareness of and effective communication with other learners.

Outcomes from a learning situation are classified in terms of CAMS: content-dependent CAMS and content-independent CAMS. Content-dependent skills are those which relate to a specific task and include memory of the task, positive affect towards the material and instructional setting, ability to monitor understanding of the specific material, etc. Content-independent CAMS are those which produce general transferable skills. These outcomes can include such skills as increased knowledge of general principles which might be applied to subsequent tasks, general motivation to learn and strategies for coping with frustration, strategies for error detection and correction, and a willingness to work with and learn from others. These task-independent skills are necessary for positive transfer to other learning and performance environments. One methodology based on the CAMS framework for instruction which can be used to teach both strategies and contents and results in both content-independent and dependent outcomes is scripted cooperation among peers.

Scripted Cooperation

Scripted cooperation is a method for structuring the cooperative learning activities of pairs of students. The word "script" is used in the same way as in a theater script where the roles of the participants and the activities in which they engage are specified. Scripted cooperation can be used with a variety of tasks, for example, writing, reading, completing laboratory assignments, etc. The use of the technique with text processing is described for purposes of illustration.

The basic script (see Figure 3) involves two students working together with the common goal of mastering academic material or tasks. Both students read a section of the text. One partner then recalls the material which has been read and the other partner tries to provide feedback on errors made. Both partners elaborate on the information to make it memorable.

Elaboration activities involve personalizing the information and relating it to previous experience or knowledge. Both partners read the second section of the text. When they finish reading the second section, partners alternate roles. They continue in this manner until they have completed the text.

This basic script can be used in a variety of ways. It can be used by students after a teacher has made a presentation of information. The teacher simply assigned students to work in pairs, explains the roles the partners need to play, and then allows the students the opportunity to practice the script. The script can also be adapted for use in more action-oriented tasks where students actually perform concrete tasks.

The activities which have been included in the script are derived from research in cognitive psychology. These activities (multiple passes; active processing; explicit use of metacognition; and elaboration) have previously been shown to be associated with positive achievement outcomes (Brown & Palinscar, 1982; Larson et al., 1985; Reder, 1980; Spurlin, Dansereau, Brooks, & Larson, 1984; Weinstein, et al., 1979).

In scripted cooperative learning, the use of multiple passes is accomplished by breaking the task into smaller manageable sections. Active processing and involvement of the students is assured by the alternation of roles and the overt recall of the material. The explicit use of metacognitive activity is assured by requiring one partner to monitor his or her partner's recall. Elaboration is ensured by requiring partners to work specifically on ways of making the information memorable.

While cooperative learning of some kind has been utilized in almost every classroom, scripted cooperation differs in a number of important ways from more usual methods of grouping students for classwork. It also differs from peer-tutoring approaches in that both

partners are equal participants in the learning experience. In peer-tutoring approaches, one person is usually an "expert" with respect to the topic. In some of the varieties of cooperative learning which are currently used (e.g., Slavin, 1983) the size of the group can vary enormously. Dyads are used in this particular version of cooperative learning because larger groups may promote the formation of coalitions, thus encouraging competition rather than cooperation (Peterson & Janicki, 1979). The quality of the information interchange in a cooperative group can also suffer when the cooperating group is large. The critical part of scripted cooperation is the "script" which regulates the activities of the participants. The sequence of activities results in the controlled activation of specific cognitive processes.

Students who have studied using "scripted cooperative learning" have consistently outperformed students who work alone (O'Donnell et al., 1985; 1986; Hall et al., 1988). They have expressed more positive attitudes toward learning than individualistic learners (O'Donnell et al., 1987), and acquire skills which result in improved performance on a transfer task (McDonald et al., 1985). The bulk of the research on scripted cooperation to date has been conducted using text-processing tasks. However, variations of this script have also resulted in superior performance on writing tasks (O'Donnell et al., 1985), performance of concrete procedures (O'Donnell et al., in press), and in communicating about such procedures (O'Donnell et al., 1988). The script has also been successfully used with elementary school children (Rottman & Cross, 1988).

Why Scripted Cooperation Works

Scripted cooperation works to produce content-dependent and content-independent outcomes because it provides the learner with an opportunity to rehearse and more deeply

process information. It also provides an opportunity for a learner to reflect on his or her own skills and observe another's skills.

The use of a script in cooperating with a partner provides the opportunity for a learner to observe another engaging in cognitive activity by making certain aspects of thinking visible. Because thinking is such a private activity, it is impossible to observe. Unlike other skills which are clearly observable (e.g., riding a bicycle) and can be imitated or modeled, thinking must first be made visible. The inclusion of such activities in a script as summarization to a partner makes some of that thinking visible. When a learner overtly summarizes information, the learner is making public his or her understanding, organization, and memory of the information read. Thus, an observing partner is provided with an opportunity to "model" effective skills or understand difficulties experience by others.

While serving as a model of cognitive, affective, and metacognitive activity to the observing partner, the "modeling" partner is also experiencing an initial practice of his or her understanding and communication ability. People have traditionally been found to be weak at metacognitive activity (Brown, 1978). The initial practice of summarization is likely to "trigger" the learner's awareness of his or her understanding.

Potential of Scripted Cooperation for Deaf Students

The use of scripted cooperation by deaf students has enormous potential. First, the use of scripted cooperation as part of classroom instruction relieves the teacher of some of the responsibility for transmitting information, freeing time to monitor students and provide additional assistance to those in need of special help. It is also hypothesized that deaf students are likely to accrue the kinds of benefits associated with the use of this technique with hearing students.

Another important benefit associated with the use of scripted cooperation is its potential to promote positive affect toward the instructional context. Too often the early experiences of deaf children in school are dominated by failure. Continued failure has been shown to be associated with increased absenteeism and drop-out rates among hearing students (Moos & Moos, 1974). The use of cooperative learning may improve the chances of success. Some preliminary work on cooperative test-taking, for example, has shown that students do better on tests when they work in pairs (Lambiotte et al., 1984).

Another important potential benefit associated with the use of cooperative learning in the classroom relates to current trends in the placement of deaf students. There has been an increasing trend toward placement of deaf children in public schools with a corresponding decline in the numbers placed in residential schools (Moores, 1988). The size of the available programs for deaf students in the public school system varies enormously. Although placement of deaf students in the "mainstream" has been associated with positive academic achievement, deaf students who have been integrated into the public school system experience personal and social difficulties (Reich, Hambleton, & Klein-Houldin, 1977), interact more frequently with teachers than with peers (Anitia, 1982), and have lower self-esteem than deaf students in residential schools (Farrugia & Austin, 1980). The use of scripted cooperative learning in the context of a mainstreamed school setting has the potential to promote interaction among the various students. In situations where there are opportunities to interact, deaf and hearing students do develop friendships (Ladd, Munson, & Miller, 1984). Cooperative learning among deaf and hearing students is one method to foster interaction within a classroom. Previous research on cooperative learning has shown that cooperative learning experiences result in improved attitudes toward cultural differences (Sharan, 1980).

Work in Progress

The initial exploration of the impact of knowledge maps and the use of scripted cooperative learning will occur in the context of college learning. The efficacy of the use of scripted cooperation and knowledge maps will be evaluated in comparison to individual review of material and text presentations of material in the context of undergraduate biology classes.

Cooperative Learning

Students in three intact laboratory sections of introductory biology courses at Gallaudet University will be the participants in the evaluation of the potential efficacy of cooperative learning as an instructional/learning strategy. A comparison will be made between the achievement of students who use cooperative learning to process the information presented in the laboratory instruction with that of students who do not have this experience.

The same instructor will teach all three sections. Two of the classes will be randomly selected to receive cooperative learning experiences. The third section will be taught in the usual manner. The instructor will first present declarative information about the targeted topic. Upon completion of the instructor's presentation, students in the cooperative learning classes will be randomly assigned to work in pairs. Students will receive a handout which explains how the script works. The instructor of the class will go through this handout with the students, explaining each step in the process.

One student will then summarize the first part of the information for his or her partner. The partner's role will be to attend carefully to the summary and subsequently provide feedback on the accuracy of the summary. Partners will then switch roles and process the second half of the material. Students in the "normal" instruction section will be allowed time to individually

review the information presented by the instructor. Outcome measures of interest will include immediate and delayed measures of performance on tests related to the information presented.

Knowledge Maps

The potential of knowledge maps for the presentation and utilization of information will also be evaluated in the context of laboratory sections of introductory biology classes at Gallaudet University. Two sections of students will be participants in this evaluation. For a given topic, two sets of lecture materials will be prepared. One set of materials will consist of lecture materials presented in the traditional text-based manner. The second set of materials will consist of knowledge-map versions of the same materials. The two sets of materials will be isomorphic with respect to content.

In one class, the instructor will present the information using the traditional methods/materials. In the second class, the information will be presented via knowledge maps. Outcomes of interest from this comparison will include immediate and delayed performance on tests covering the material presented.

A second potential use of knowledge maps will also be explored. Two sets of materials will again be prepared--knowledge maps and text-based version of the materials. The targeted topic for this comparison will be different to that used previously. Students will be asked to use either text or knowledge map versions of a laboratory procedure to actually complete the procedure. It is anticipated that the use of knowledge maps will be more effective as task performance aids in the completion of laboratory assignments than regular text versions. The cues involved in the spatial layout of a procedure reduce the difficulties inherent in following instructions. Outcome measures of interest will be similar to those already mentioned.

The results of these initial explorations will be presented at the conference itself. Information emerging from these initial explorations will provide an indication of whether or not the use of these tools is viable within the context of deaf education, and if, in fact, their use results in positive academic achievement and other outcomes. Additional information about the difficulty of implementing these techniques and informal observations of the difficulties experienced by students in using these techniques within the context of ongoing instruction will also be presented.

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